

PLAN
FOR CREATING
FOREST EXPERIMENT STATIONS

by
Raphael Zarr
May 6, 1905

RETURN TO FILE
SILVICS

6/1/88
I am for this,
with some changes.
May 6, 1908.
JEP

Memorandum for Mr. Pinchot:

In accordance with your instructions of December 11, 1907, to work out a scheme for inaugurating forest experiments on the National Forests, I have the honor to submit the following plan for the creation of Forest Experiment Stations.

Respectfully,

Raphael Zon

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PLAN FOR FOREST EXPERIMENT STATIONS

NEED AND IMPORTANCE

Considering that the federal forest policy of the United States has now become fairly well established, and the education of the people in forest matters has advanced beyond the point where general information of empiric origin is wholly satisfactory, the time would seem to be ripe for taking up the problems which confront the practicing forester and the owner of forest lands, in the most systematic manner, and in a way which will furnish the most valuable object lesson. Forest experiment stations are needed. The idea is not a new one, and has already been developed quite extensively in several European countries. The value of the systematic organization of forest research work was officially recognized in Germany in 1870, when the first Forest Experiment Station was established in Baden, in connection with the Polytechnikum at Karlsruhe. Half a dozen of the German States followed the example, instituting main experiment stations in connection with forest schools, and branches in various Forest Districts. The cost to the German government is in the neighborhood of \$30,000 annually. The work done is intensely scientific, and the policy of forest experiment stations is steadily growing in favor.

In India, where after half a century of administration the status of the forest is hardly better than in the United

States at present, the work of research has been almost wholly neglected, and the result is apparent in the poor progress of technical forestry. Very lately, however, the need has been recognized by the government, and an Imperial Forest Research Institute and College has been created at Dehra Dun, with a faculty chosen from the Imperial Forest Service.

In the United States considerable research work has already been done in connection with forest problems. There were attempts to determine the fundamentals of silvics, to find the relative strength of the different species, and to study the nursery methods and the species suitable for planting, yet all of this work is in its infancy, and no results of importance have been obtained. The great mistake in all such work has been the lack of persistence and permanence which has characterized it, and a failure in most cases to consider all of the factors which were involved, and to recognize the relation of the particular piece of work to the whole scheme of forest principles.

It is manifestly the duty of the federal Forest Service to take the lead in the research work of forestry as it has taken it in the administration of the forests. This has already been recognized to some extent by the organization of scientific offices in the Service. With the general tendency of the present policy to distribute the work of the Service among field offices, and to retain the control and supervision in the Washington office, there can be found nothing inconsistent in the step toward the establishment of forest experiment stations

in the National Forests. The advantages of economy and greater efficiency are apparent. Under the present system of conducting investigative work, assignments to an extensive area are usually necessary, and at the end of a short and expensive season the observer returns to Washington to make a report, and finds the data obtained insufficient and unsatisfactory. The new system provides for the permanent assignment to a given region of specially trained men, who will have opportunity to become thoroughly familiar with their region and whose work will thus be conducted with the greatest effectiveness and least expense. Forest experiment stations in the eastern portion of the country, of equal importance and with the same general objects, involve some rather different propositions in the matter of organization, and their detailed consideration will therefore be left until a later time.

It is thought advisable that there be established in each of the silvicultural regions of the West, a Forest Experiment Station. The distribution of these will perhaps conform to the Inspection Districts, though this is an unessential matter. The purpose of ^{these} such stations ^{is} will be to carry on, on areas segregated from the usual business enterprises, experiments and studies leading to a full and exact knowledge of American silviculture, to the most economic utilization of the products of the forest, and to a fuller appreciation of the indirect benefits of the forest. Each station should be allowed an area sufficient for the proper handling of short-period experiments, for experiments requiring a number of years, and for the maintenance of

model forests typical of the silvicultural region. These areas will furnish the most valuable, instructive and convincing object lessons for the public in general, for professional foresters, lumbermen, and owners of forest land, and especially for the technical and administrative officers of the National Forests. They should be made the meeting grounds for Supervisors, Rangers, and Guards, where demonstration may be given for the education of these men, and an active interest stimulated in the technical side of the forest work--an interest which could not be engendered by any amount of literary or oratorical effort. The value of demonstrations for making a direct appeal to the laymind has already been proven in scientific agricultural work, and there is no reason to suppose that it will be less successful in forestry.

The value of the uniformity of methods in dealing with forest problems (and especially with silvical problems, on which exact data is still lacking) which the organization of the Forest Experiment Stations would make possible, cannot be emphasized too strongly. General problems would be treated at all of the stations simultaneously; local problems in the region to which their results apply. All of the modifying factors which enter into the results of experiments, would be measured by observations covering many years, and would be thus determined once for all, with the greatest economy, and the least duplication of work. Likewise, in the publication of results, the greatest economy would be effected, and the greatest

usefulness attained by treating the questions topically rather than regionally, and by presenting the conclusions in the most terse, concise, and uniform style.

PROBLEMS.

The problems to be attacked by the technical force of the Forest Experiment Stations divide themselves naturally into two main groups: forest problems proper, and those concerned with the indirect influences of the forest. These groups are again divided, the first into

1. Tree studies
2. Stand studies

and the second group into

1. Studies of atmospheric or meteorological influences,
2. Studies of run-off and ground-water influences.

A mention of some of the problems which present themselves for early attention, will help to show the great need for Forest Experiment Stations.

Forest Problems Proper: Tree Studies.

The studies of individual trees in the forest will embrace those points usually included in a silvical study; habitat, silvical requirements, form and volume, growth, seed-ing capacity, enemies and diseases, phenology, improvement, *and* quality, and durability of products. The requirements of trees will be studied not only by general observations, but by actual measurements of the physical factors in which they are growing and the results will be expressed as far as

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without meas.*

possible in absolute figures. Thus in studying the light or moisture requirements of a species, the actual light intensities or water contents of the soil in which it grows will be measured in conjunction with a study of the rate of growth.

Suggestive experiments and studies ~~of~~ this class are:

1. Extensive introduction of new forest and range species.
2. Improvement of forest and range species by selection, hybridization, and grafting.
3. Light requirements of species, with scales of tolerance, based on photometric and spectroscopic observations.
4. Soil and moisture requirements of species, determined by means of soil sample analyses.
5. Seeding capacity and periods of bearing, by species and by stands.
6. Phenological observations--time of leafing, flowering, fruiting, etc.
7. Influence of species--situation, and soil on root systems.
8. Influence of species, situation, and soil on shape and volume of stems.
9. Influence of situations, light, and moisture on size and shape of crown.
10. Influence of physical factors on quality and strength of wood.
11. Insect pests and their eradication. / B.S.

12. Fungous diseases and their eradication. B.P.S.

13. Frost-~~and~~ winter, and drought-hardiness of species.

14. Original vitality of tree-seeds, and the influence of various methods of storage.

15. Influence of nursery methods on the success of field planting.

Forest Problems Proper: Stand Studies.

*Areas scattered if
use a small part
of actual sales etc.*

The studies of stands are largely studies of types; their origin, characteristics, permanency; their development from seedling stage to maturity, with preparation of yield tables; methods of improvement thinnings and reproduction cuttings. The aim should be to produce in each type characteristic of the region, a model Forest, or perhaps several model areas, each managed according to a different system. The model Forest will not stand idle; it will be continually used for some experiment or combination of experiments which may be carried on under accurately measured conditions.

Suggestive experiments and studies of this class are:

1. Origin and succession of types.
2. Development of the permanent type from seedling stage to maturity, with stand and yield tables.
3. Methods of thinning and their influence on growth, with exact measurements of crown densities.
4. Methods of reproduction cuttings.
5. Effects of fire on reproduction, and on older

trees as shown by growth measurements.

6. Effects of grazing on reproduction, and on older trees as evidenced by growth.

7. ~~Regeneration~~ ^{Reproduction} of over-grazed areas, by natural and artificial means.

8. ~~Regeneration~~ of burned and cut-over areas.

9. Extension of the forest into denuded and arid areas, by natural and artificial means.

10. Chaparral problems.

11. ~~Regeneration~~ of the forest in swampy or over-flow lands.

12. Silvical importance and final disposition of tree-weeds.

13. Disposal of brush.

14. Silvical and economic value of forest litter.

Accurate yield tables covering all the stages in the growth of the forest, and including all species, soils, and situations, would be extremely valuable at the present time, when the question of natural resources is being so strongly agitated, and in fact the federal forest policy can never become thoroughly settled until these are obtained, and until an accurate estimate may be made of the productive capacity of our forest lands.

Indirect Influences: Meteorological Observations.

Conf W.B.

Meteorological observations should be made at the Forest Experiment Stations, not only for the purpose of

obtaining data which will show the influence of the forest on various factors of climate, but in order to furnish the data necessary for a proper understanding of all of the experiments in which the climatic factor enters into the results. A cooperative plan has lately been agreed to by the U. S. Weather Bureau, by which they will furnish the instruments for observations of air temperature, humidity, precipitation, and wind-velocity. In many cases two sets of instruments will be installed at the same observation station--one in the forest and the other in the open. Observations will be taken by Forest officers, when possible. At Forest Experiment Stations there should be several sets of instruments covering the entire range of types and large differences in topography. Self-registering instruments must be largely depended upon, and in addition to the observations desired by the Weather Bureau, those on evaporation should be taken.

Suggestive studies along meteorological lines are:

1. Effect of elevation, aspect, and forest cover on the mean temperature and temperature extremes.
2. Effect of elevation and forest cover on the total precipitation and the proportion of rain and snow.
3. Effect of elevation, aspect and forest cover on the melting and evaporation of snow.
4. Evaporation and transpiration from bare soil, sod and forest cover.

Indirect Influences: Run-off and Ground Water Observations.

There is still some skepticism as to the great value of the forest cover in retaining the water of precipitation and preventing its rapid run-off. The results of European investigation of this and other matters concerned with the indirect influence of the forest, must not be taken as final, or even as having very great bearing on the question as presented in this country. The fact that Europeans have found very little difference between the climate inside, and that outside the forest, that they have noted no great change in the flow and quality of their streams, etc., is easily accounted for on the ground that their observations have covered no great range of climatic conditions, and that they have practically all been made since the time when the forest area assumed its normal position in the balance. No such extremes of climate as this country possesses or such a change in the forest cover as has been witnessed here in ^{the} past century, are to be imagined for any country in Europe, and hardly for the whole continent.

It is recognized that it would be extremely difficult to obtain accurate results on an experiment involving even the smallest water-shed, and the experiment would require a time sufficient to bring about considerable change in the forest cover, and then a return to the original condition. Laboratory experiments on a large scale, with all of the factors completely in control, will furnish much more reliable and convincing results in a comparatively short time. They should be undertaken

at the Forest Experiment Stations. Some of the points to be proven are:

1. Relation of forest and range cover to the proportion of run-off, evaporation water, and ground water.
2. Relation of forest and range cover to the time of run-off, and the period of usefulness of ground water.
3. Relation of forest and range cover to erosion, turbidity, of streams, and deposition of silt.
4. Relation of forest and range cover to the duty of water in irrigation.
5. Value of soil-binding and bank-retention by means of planting.

LOCATION OF STATIONS

There should be one Forest Experiment Station in each of the silvicultural regions of the West (and at a later date, if conditions permit, one each in the White Pine Region, the Appalachian Hardwood Region, and the Southern Pine Belt). It is highly desirable that a single Forest representing all of the conditions typical of the region, be selected, and a portion of its area set aside for the purposes of the Experiment Stations. Where it is necessary to locate some of the areas remote from the main body, the work done on them will necessarily be less intensive, and the results therefore less valuable.

The actual locating of sites for Experiment Stations

must be done in the field, after very careful consideration of the many advantages of each Forest. Connection with a water-power or irrigation project is desirable. The setting aside of forest areas for experiments should progress as the needs of the work demand. The first steps must be taken very cautiously.

The following locations for western Stations are suggested tentatively:

1. Priest River, Idaho.

Inspection District 1.

Western White Pine Region.

It is very desirable that this rather limited region be studied thoroughly from the silvicultural standpoint, and the perpetuation of the valuable white pine be insured as far as possible. Available statistics seem to indicate that the Priest River Forest is about average for the region. The proportion of types shown is,

Yellow Pine and Larch, 22 per cent
Lodgepole, 12 per cent
Spruce-balsam, 10 per cent
Miscellaneous, 55 per cent.

W.P. ?

✓ 2. Cascade Range (N), Oregon.

Inspection District 6.

Douglas Fir Region.

The greater part of this Forest is on the west slope of the Cascades where Douglas fir predominates and reaches its best development. The portion of the Forest on the eastern slope includes some of the northern Yellow Pine Region, which will not be represented by any other station, as at present

planned. The proportion of the various types in the Forest as a whole is

Pine and Larch, 12 per cent
Red Fir, 55 per cent
Lodgepole, 15 per cent
Hemlock and Fir, 18 per cent.

✓ 3. Yellowstone (N), Montana.

Inspection District 1.

Northern Lodgepole Region.

The Absaroka Division of the Yellowstone represents perfectly the conditions typical of the northern Lodgepole region. It is, moreover, connected with the Huntley irrigation project, and would serve a double purpose as a site for an Experiment Station. The proportion of types in this Forest is

Douglas Fir, 15 per cent
Lodgepole, 50 per cent
Spruce-balsam, 35 per cent.

4. Pikes Peak, Colorado.

Inspection District 2.

Southern Lodgepole Region.

The Pikes Peak Forest is especially desirable as a site for a Forest Experiment Station on account of the wide range of altitude which it covers, and the versatility of physical conditions within its limits. The establishment of an Alpine Laboratory in connection with this Station, is also much to be desired. The proportion of species in this Forest is

Pine and Larch, 30 per cent
Lodgepole, 40 per cent
Spruce-balsam, 12 per cent
Miscellaneous, 18 per cent.

Sierra?

? 5. Tahoe, California-Nevada.

Inspection District 5.

Sugar Pine Region.

The Tahoe Forest, on the east slope of the Sierras, seems most suitable for the location of an Experiment Station, and its forests are typical of the Sugar Pine-Yellow Pine Region. Its boundaries include a large portion of the watershed area of the Truckee-Carson irrigation project. The proportion of species is approximately

Yellow pine, 50 per cent
Sugar pine, 12 per cent
White fir, 12 per cent
Incense cedar, 14 per cent
Others, 12 per cent.

✓ 6. San Francisco, Arizona.

Inspection District 3.

Yellow~~stone~~ Pine Region, southern.

The San Francisco National Forest represents the forest conditions typical of the Southwest, and is considered very desirable. The Black Mesa Forest is perhaps equally desirable and has the additional advantage of including a large part of the watershed area of the Salt River irrigation project. The proportion of species is about the same in both, and the decision must rest more on the question of accessibility than on any other point. The reproduction of yellow pine is the great silvicultural problem.

Yellow pine 25 per cent
Pinon, 30 per cent
Juniper, 25 per cent
Others, 20 per cent.

Dr. C. A. ...
Shirley

EQUIPMENT OF STATIONS

The headquarters of the Forest Experiment Stations should be located as closely as possible to those of the Forest Supervisor, and should also be readily accessible to the forest. The latter is by far the more important consideration, since the nature of the work at nearly all seasons will be such as to demand daily attention by the observer. The buildings should be sufficiently elaborate to insure comfortable permanent quarters for one or more observers. There should be, in connection with at least one of the Stations, a hot-house in which experiments with the tolerance of seedlings, the germination of seeds, the moisture demands and the transpiration of seedlings, etc., can be carried on during the winter when out-door work is not pressing. A cold-storage house for experiments in the storage of seeds and seedlings will also be found necessary if work of this sort is to be done by the Forest Experiment Stations. There will be needed in both field and laboratory work of the Stations a number of instruments for accurate measurements. The cost of all equipment and apparatus may well be charged to the fund for permanent improvements, since they will form an important part of the working capital of the Forest Service for all time.

Where the use of work horses or pack animals will facilitate the work of the Stations, they should be furnished and maintained by the Service.

ORGANIZATION OF FOREST EXPERIMENT STATIONS.

Control

The control of the Forest Experiment Stations should rest in a single office of the Forest Service. The work of the Stations, while having unlimited scope and general importance to forestry, will be mainly concerned with the silvicultural problems in the management of the National Forests and of the private forest lands of the country. It is, then, logically the work of the Branch of Silviculture. Within this Branch, the actual work of managing and advising the management of the forests falls to one Office; the work of planting and advising the plantation of forest lands falls to a second Office, and the more scientific investigative work of silviculture comes within the scope of Silvics.* The work of the Stations is to be purely investigative, except in so far as they will have the control of the limited areas of the model forests. It would seem to correspond most closely with the work of the present Office of Silvics.

There should be created in the Office having charge of this work, a Section of Experiment Stations, for their more immediate control, and the Chief of this Section should also have charge of the permanent sample plots instituted by the Forest Service at various points in the United States, and should direct

* The term "Silvics", while very good and expressive in itself, is perhaps too technical for the lay mind, and its use as the name of an Office is hardly in keeping with the general policy of the Forest Service of holding its work within the easy reach of the public. It might well be replaced in this capacity by the term "Forest Investigations", which would not, properly considered, suggest any encroachment on the work of any other Office.

the periodic examination of these plots. Each Station should be in the charge of a Director, who would be responsible to the Chief of Experiment Stations for the proper conduct of the work of the Station, and would carry on only such experiments as were approved by the Chief.

Personnel of Stations

The work of Forest Experiment Stations is of sufficient magnitude and importance to demand the services of a most broad and capable man as Director. It is believed that there will be considerable difficulty in filling the positions satisfactorily. The Director must not only be a man of scientific training, exactness in habits of work, and familiarity with the deeper principles of silviculture, ~~but~~ he must be well versed in all of the work of the Forest Service, ~~and~~ he must be able to see the inter-relation of the various problems studied, and he must have sufficient executive ability to obtain from his assistants scientific work of the same high character as he himself would perform. He must also be able to demonstrate to the lay mind the value and practical application of his results, since the use of the Experiment Forests as models and examples is among their most important. The Director must be, in the technical line, even better-trained than the best Supervisors and Inspectors, and it is therefore desirable that he be removed, as far as possible, from the authority of these officers. This is not without precedent, for in all of the European countries the scientific workers are made almost wholly independent of the administrative officers.

The Supervisor of the Forest on which an Experiment Station is located should act as the business manager of the Station, conducting the purely routine business, and he should be referred to in all matters having an influence on the Forest as a whole.

The Director should have as many technically-trained assistants as are needed to properly conduct the work of the Station, and to insure the work already done. Forest Assistants who are assigned to the Station temporarily, and for special studies, will confer and go over the ground with the Director, and the work may then be left in the charge of the Director.

The services of Technical Assistants, Rangers, Guards and laborers, for purposes such as the marking of timber, the burning of brush, or any of the crude labor of the Station, and the intermittent services of these officers for purposes such as the periodic reading of instruments, should be obtained through the Supervisor by a request in writing from the Director. Supervisors should make every effort to furnish the desired assistance, but should not be held accountable for the same unless the request is submitted at least two weeks before the beginning of the period when the work is to be done. In cases where the desired assistance cannot be given, Supervisors should give due notice to that effect.

Location and Administration

The Office in charge of Experiment Stations should cooperate with the Office of the Forester and the Office of organization, as represented by the Inspectors and Supervisors, in locating

suitable sites for the Stations, and in allotting areas for the purposes of the experiments and the model forests, on the National Forests. Upon the approval of the selections by the Chief of Organization and the Chief of Experiment Stations, the designated areas should be set aside and known as "Experiment Forests". ✓

The patrol of the Experiment Forests should be the same as though they had not been segregated, and no operation which might have an influence on the Forest beyond their limits should be started without the consent of the Supervisor. In order to insure exemption from interference by outside parties, the Experiment Forests should be withdrawn from entry under the Land or Mining Laws of the United States, "for administrative purposes." They should not be open for timber-sales or for the purposes of grazing except by the request and under the direction of the Office having charge of Experiment Stations. ✓

The funds for conducting the work of Experiment Stations should be included as a special portion of the allotment for the Forest in which each is located, and the Supervisor should be the custodian of these funds as he is of the other funds of the Forest. ✓

Cooperation with other Offices of the Forest Service.

The Office in charge of Experiment Stations should consider the plans of any other Office of the Forest Service for experiments to be carried on at the Forest Experiment Stations, and upon the approval of the plans by the Chief of Experiment Stations, the experiment should be inaugurated at the Station or Stations most favorably situated for obtaining the desired results, and ✓

Chief of SS in charge through
Chief of SS

an attempt should be made to accommodate any assistants who may be assigned to the work. Especially is this form of cooperation between the Experiment Stations and the Offices of the Branch of Silviculture to be encouraged, since the solution by experiment of the larger problems in the planting and management of the National Forests, and the silvicultural problems which present themselves in the various forest regions of the United States, must be the main object in the inauguration of the Experiment stations. Such Stations, will, however, on account of their permanency and equipment, be in position to take up any form of problem which is presented. In order to avoid duplication of work, the methods of procedure in these experiments must be largely determined by the Chief of Experiment Stations. ✓

Publication of Results

In order to furnish to those who are concerned with it, at the earliest opportunity, the information on the results of experiments conducted at the Experiment Stations, and especially those which necessarily run through a number of years, the material should be published in an ~~annual~~ report of the Forest Experiment Stations, which should emanate from the Section, and be issued as soon as practicable after the end of the calendar year. All experimental work should be taken up in this report, whether carried on in cooperation with another Office, or in the initiative of the Office in charge of Stations. The report should be arranged topically rather than regionally, and should consist of progress reports on unfinished experiments, and summary reports on experiments completed during the current year. Upon the completion

of a definite experiment, the results may be published in more enlarged form as a separate circular or bulletin.

Cooperation with other Bureaus and Departments of the Federal Service, and with State Offices.

Cooperative experiments ^{with} ~~between~~ other Bureaus of the Government, or Offices of the States, should be taken up by the Experiment Stations under the plans approved by the Forester, whenever the value of these experiments to the national forest policy can be demonstrated. The results of such experiments should be published in the Annual Reports of Experiment Stations, in so far as they are of value to forestry, and no agreement should be made between cooperating parties which might preclude this privilege of the Forest Service.

Cooperation with Institutions of Learning.

Cooperation with the Forestry Departments of Universities and Colleges is especially to be desired. These may often furnish lands on which the conditions for experimental work are ideal, and observers whose training is excellent. No agreement should be entered into which does not provide for government publication of the results of experiments.

Cooperation with Business Corporations, Firms and Private Individuals.

Each Sta
The ~~Forest Service~~ should consider plans for cooperating

with private individuals, firms and business corporations only when the problems to be studied are obviously of a general character, and the results applicable to a considerable area. The experience with sample plots on the lands of private parties has so far been rather unsatisfactory, and it will in general be found more profitable to carry on the experimental work on public lands, and especially so where a long period is needed for obtaining the results. Private parties cannot usually be depended upon to furnish the protection necessary for the proper conduct of experiments.

ESTIMATE OF COST

The following is a rough estimate of the cost of establishing and maintaining the Forest Experiment Stations. The initial cost should be charged to the fund for permanent improvements. It may be divided on a ten-year basis and included in the cost of maintenance, which should be included in the yearly budget for the Forest on which the Station is located.

Initial Cost

1 Station:

Station Headquarters - - - - -	\$1000
Stables and Outhouses - - - - -	400
Animals (work teams, etc.) - - - - -	250
Vehicles - - - - -	150
Laboratory and field equipment - - - - -	500
Contingent for enclosures, special protection (fire-lines) etc. - - - - -	1000
Total per Station - - - - -	\$3400

Initial cost 6 Stations - - - - -	\$20400
Single Hot-house - - - - -	600
Single Cold-storage House - - - - -	600
Total Initial Cost - - - - -	\$21600
Dividedd on ten-year basis - - - - -	\$2160

Cost of Maintenance

1 Station:

Salaries, technical force, labor, etc. - - -	\$4000
Improvements and maintenance- - - - -	-1500
Total per Station - - - - -	\$5500

Cost maintaining 6 Stations - - - - - \$33000

TOTAL COST per year - - - - - \$35160

This amount, \$35,160, is almost exactly equal to the amount spent during the current year for a single experiment - the disposal of brush on the National Forests - an experiment which has been carried on without sufficient system and control to make the results obtained either definite or valuable, except in the most general way.